ST. CROIX RIVER BASIN

WASHINGTON COUNTY, MAINE

MILLTOWN POWER STATION DAM

ME 00217

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

REPORT DOCUMENTATION PAGE

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14. ABSTRACT
The Milltown Power Station Dam is a small dam with a low hazard potential, located on the St. Croix River straddling the U.S. - Canadia border in eastern Maine. The dam serves as a control structure for the New Brunswick Hydro-Electrical Plant, which has a generating capacity of about three megawatts using seven turbine units. The hypothetical dam failure analysis calculated a breach surcharge of 24,000 cfs, which was routed through the downstream channel without causing serious property damage or loss of life.
The project presently generates about three megawatts using seven units. The structure is approximately 25 feet high (with flashboards installed) and 540 feet long including the powerhouse and gatehouse. The dam is essentially a control structure utilizing the river flow for power generation. Because the project is a run-of-the-river operation with little shortage capacity (130 ac-ft) and a height of only 25 feet, it is classified as a small dam in accordance with the corps of Engineers Recommended Guidelines.

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Dams, inspection, dam safety, St. Croix River basin, Washington County, Maine

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NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification No.	:	ME 00217
Name of Dam	:	Milltown Power Station Dam
County & State	:	Washington, Maine
Date of Inspection	:	November 14, 1979

SUMMARY

The Milltown Power Station Dam is a small dam with a low hazard potential, located on the St. Croix River straddling the U.S. - Canadian border in eastern Maine. The dam serves as a control structure for the New Brunswick Hydro-Electric Plant which has a generating capacity of about three megawatts using seven turbine units. The hypothetical dam failure analysis calculated a breach surcharge of 24,000 cfs which was routed through the downstream channel without causing serious property damage or loss of life.

DESCRIPTION

The Milltown Power Station Dam is located on the St. Croix River on the Canadian - U.S.A. border in Milltown, Maine at approximate latitude 45 degrees 10.5 minutes and longitude 67 degrees 17.5 minutes. The structure is owned and operated by the New Brunswick Electric Power Commission. The plant operator is Mr. Jim Cummings, telephone 506-466-5411.

The project presently generates about three megawatts using seven units. The structure is approximately 25 feet high (with flashboards installed) and 540 feet long including the powerhouse and gatehouse. The dam is essentially a control structure utilizing the river flow for power generation. Because the project is a run-of-the-river operation with little storage capacity (130 ac-ft) and a height of only 25 feet, it is classified as a small dam in accordance with the Corps of Engineers Recommended Guidelines. Starting at the right side (American side) of the dam there is: (1) five timber gates 7.5 feet wide which are remotely controlled; (2) a 100' rollway section with 1.5 feet of flashboard capability; (3) six 15-foot wide stoplog openings; (4) the powerhouse with three separate intakes; (5) a single unit separate from the adjacent powerhouse; (6) a second powerhouse with three units; and (7) the fishway adjacent to the left bank. A schematic plan view is included in Appendix A.

The rollway crest is at Elev. 42.9 NGVD plus 1.5 feet with flashboards. The gates on the left side of the dam have sills at Elev. 29.9 with provisions for adding stoplogs to Elev. 44.9. Four gates at the right bank have sills at Elev. 33.9 with the fifth gate two feet higher.

The hydro plant is essentially a run-of-the-river operation. The reservoir upstream extends to the rapids at the village of Baring, 3.5 miles upstream, with small storage. The drainage area for St. Croix River above Milltown is 1460 square miles according to the U.S.G.S. With the water elevation at 46.9 the following discharges are given: (1) 22,500 cfs with all stoplogs removed from the 15'-wide openings; (2) 2,500 cfs with only the flashboards at the rollway removed; (3) 5,000 cfs with the gates in the gatehouse at the right bank open; (4) 30,000 cfs with all gates, stoplogs, and flashboards removed. With a 24' head the turbine units will pass 2200 cfs. The highest flow recorded at the dam according to the New Brunswick Electric Power Commission was a discharge of 25,000 cfs on May 1-2, 1923. In November 1976 the project was inspected by the Acres Consulting Services Limited. A copy of their report is included in Appendix A.

VISUAL INSPECTION

The general condition of the Milltown Power Station Dam was good as determined from the visual inspection on November 19, 1979 by Mr. L. Seward and Mr. J. Jonas, registered civil engineers with Chas. T. Main, Inc. At the time of inspection two of the 15' wide openings adjacent to the powerhouse had several stoplogs removed and were discharging. The flashboards at the rollway section were removed and a small amount of water was spilling over the structure. Three gates on the right side were also discharging.

The normal mode of operation at the dam is to control the river flow by a combination of power releases and operating the five gates in the gatehouse against the right bank. The concrete piers supporting the gatehouse shows signs of scour up to approximately 8 inches. The gates appear to be in good working condition. On the crest of the rollway there is some deterioration, but the structure is not in a hazardous condition. The concrete base of the powerhouse is in fair condition showing some concrete scour and spalling. General maintenance and repairs are performed on the dam as required. The suspension foot-bridge is in good condition. Considering the age of the dam (the original structure was erected in the early 1900's), the structure is in good condition and there is no danger of collapse on unstability.

HYDRAULICS AND HYDROLOGY

Because Milltown dam is a control structure that can open gates to pass flood flows, a flood analysis was not performed. The hypothetical dam failure analysis was performed using the "Rule of Thumb" Guidelines recommended by the Corps of Engineers, New England District. The resultant flood wave was routed downstream in determining what damage, if any, would occur in the event of a dam failure. It should be noted that the assumptions made in using the Guidelines, that is, assuming that 35 percent of the structure is washed away during a dam failure, are somewhat unrealistic for this control structure but they do result in a conservative estimate and so, for this reason, the recommended procedures were used.

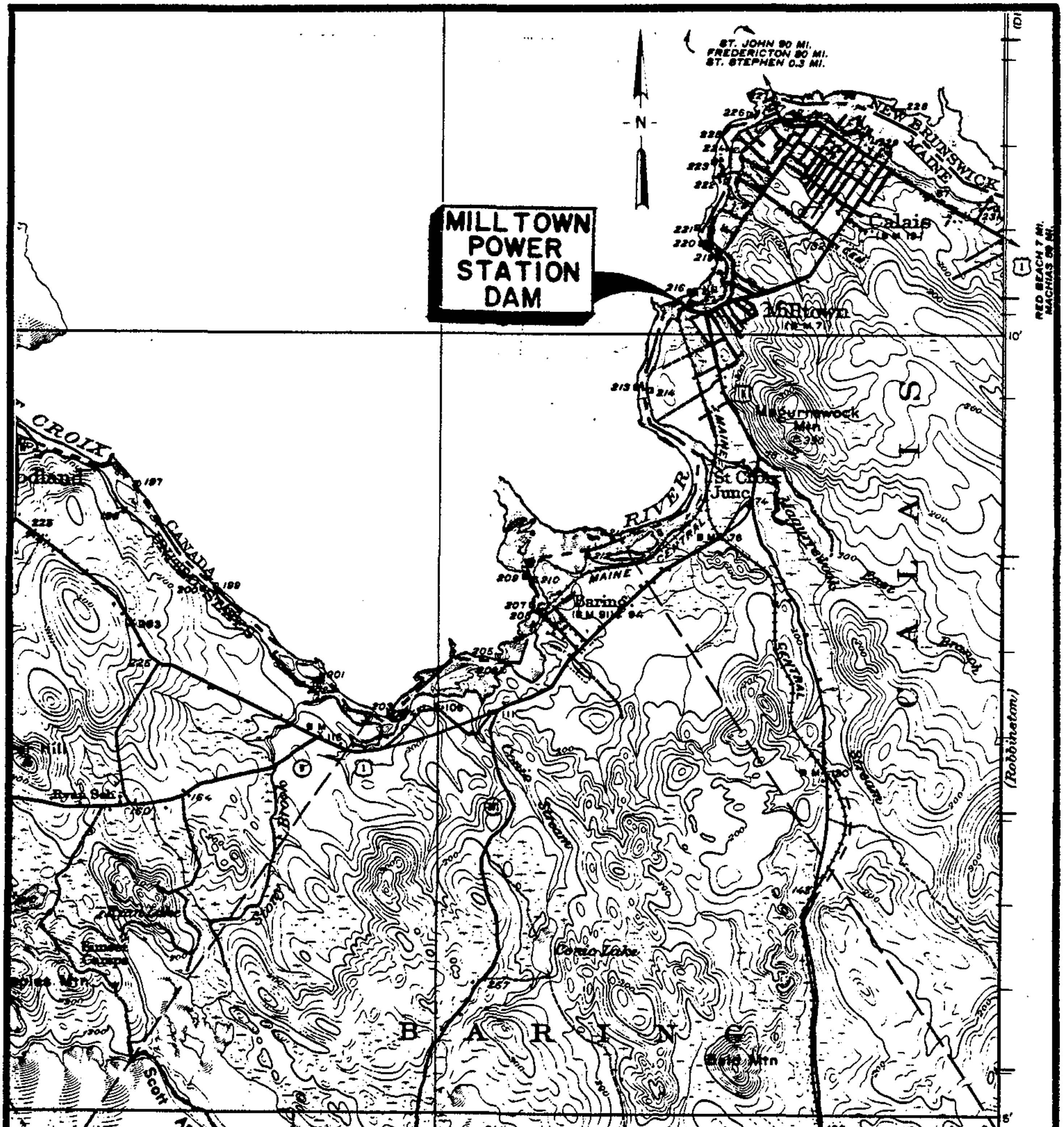
In the dam failure analysis (calculations are included in Appendix C) an average prefailure discharge of 5,000 cfs was assumed in estimating the downstream prefailure conditions. This results in a channel height of about three feet prior to the dam failure. In line with the Guidelines, the reservoir level was assumed to be at the top of the 25 foot high dam (with flashboards installed), with a corresponding reservoir storage of 130 acre-feet when the dam fails. The resultant discharge was calculated to be about 24,000 cfs which was routed downstream. The surcharge wave is 7.6 feet high immediately below the dam which diminishes to 4.4 feet approximately 7,500 feet downstream. If added to the prefailure channel height then the highest water level caused by the flood surcharge will be about eleven feet. The downstream river channel is more than sufficient to safely pass a discharge of this magnitude without causing serious property damage or loss of life. The Milltown Dam is located about 8 miles from the head of St. Croix River which spills into Passamaquoddy Bay. According to Mr. Jim Cummings, the furthest distance upstream that the tides have an effect is about one mile below the dam. Therefore, even if the breach surcharge occurred during high tide, the river channel would still be able to safely pass the flow.

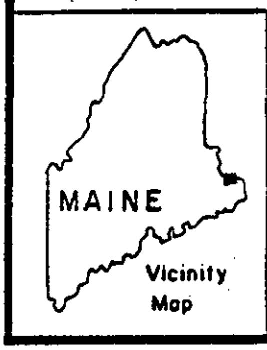
CONCLUSION

Because it is not expected that any lives would be threatened in the event of a dam failure, the Milltown Dam has been classified as a low hazard dam.

APPENDIX A

ENGINEERING DATA





FROM USGS CALAIS, ME. QUAD MAP

SCALE

1 1/2 0 Miles 1

1 : 62,500

MILLTOWN DAM LOCATION MAP

U.S. ARMY CORPS OF ENGINEERS
PHASE I INSPECTION PROGRAM

MAIN

DATE March 1981

CLIENT JOB PLATE

1345-072-1

A-1

The New Brunswick Electric Power Commission

INSPECTION OF MILLTOWN HYDROELECTRIC GENERATING STATION

Acres Consulting Services Limited
Niagara Falls, Canada

November 1976

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LIST OF PLATES AND PHOTOGRAPHS

NBEPC - INSPECTION OF MILLTOWN
HYDROELECTRIC GENERATING STATION

1 - INTRODUCTION

An inspection of Milltown hydroelectric development was carried out by Mr. S. Maitland on October 14, 1976. He was accompanied by Mr. M. Staples of NBEPC, Fredericton, on the tour of inspection.

2 - GENERAL DESCRIPTION

The development (see layout drawing) has grown piece meal since the days of the St. Croix Cotton Mill and the type of construction varies from squared granite blocks through brick, timber structural steel to mass concrete and reinforced concrete. It includes a wire rope and timber suspension bridge which gives access to the gate control structure via the U.S.A. There are seven units with a total output of approximately 3 megawatts. The operating head is 24 feet using flashboards above the rollway.

The dam has six 15-foot wide stoplog openings, a rollway section with flash boards and a section containing five timber gates 7.5 feet wide which are manually operated. There are three separate intakes complete with trashracks. The intake to Unit No. 4 is separate and placed centrally. A timber fishway goes below the powerhouse adjacent to No. 4 intake. An area upstream of Unit No. 4 over the fishway and the intake has a reinforced concrete deck supported on the wing walls and intermediate concrete columns.

Power is routed via overhead lines to the substation. The powerlines are supported on a structural steel frame bolted to the powerhouse brickwork.

3 - CONCLUSIONS

The plant is functioning smoothly despite its obvious age. The superstructure of the powerhouse is in good condition while the substructure which is mostly concrete is in fair condition. The control structures are deteriorating slowly surficially but no serious defects were noted. Maintenance is carried out annually to the worst areas and this has successfully prevented any serious problem from developing.

4 - POWERHOUSE

The brickwork and structural steelwork are in good condition. The water passages show signs of scour up to about 9 inches deep. These areas should be repaired to ensure the continuing integrity of the structures. The concrete surfaces of the wing walls at intake No. 4 unit are deteriorating to a depth of 1 or 2 inches but concrete below this depth is still sound.

The reinforced concrete deck over the intake to No. 4 unit has spalled severely on the underside and the reinforcement is exposed over large areas. this area should be propped to prevent collapse which could be sudden and without warning. A thorough investigation of its condition and strength should then be undertaken so that long-term remedial measures can be undertaken. It may be that large sections of it can be demolished but the stability of the intake walls may well depend on the strutting effect of this slab and this should also be checked.

The timber fishway is in poor condition and will not last much longer.

There are two structural steel beams supporting unit No. 4 turbine which are subjected to continual splashing and as a result are corroding excessively. These should be strengthened with extra plates or replaced and protected with an appropriate type paint or epoxy coating.

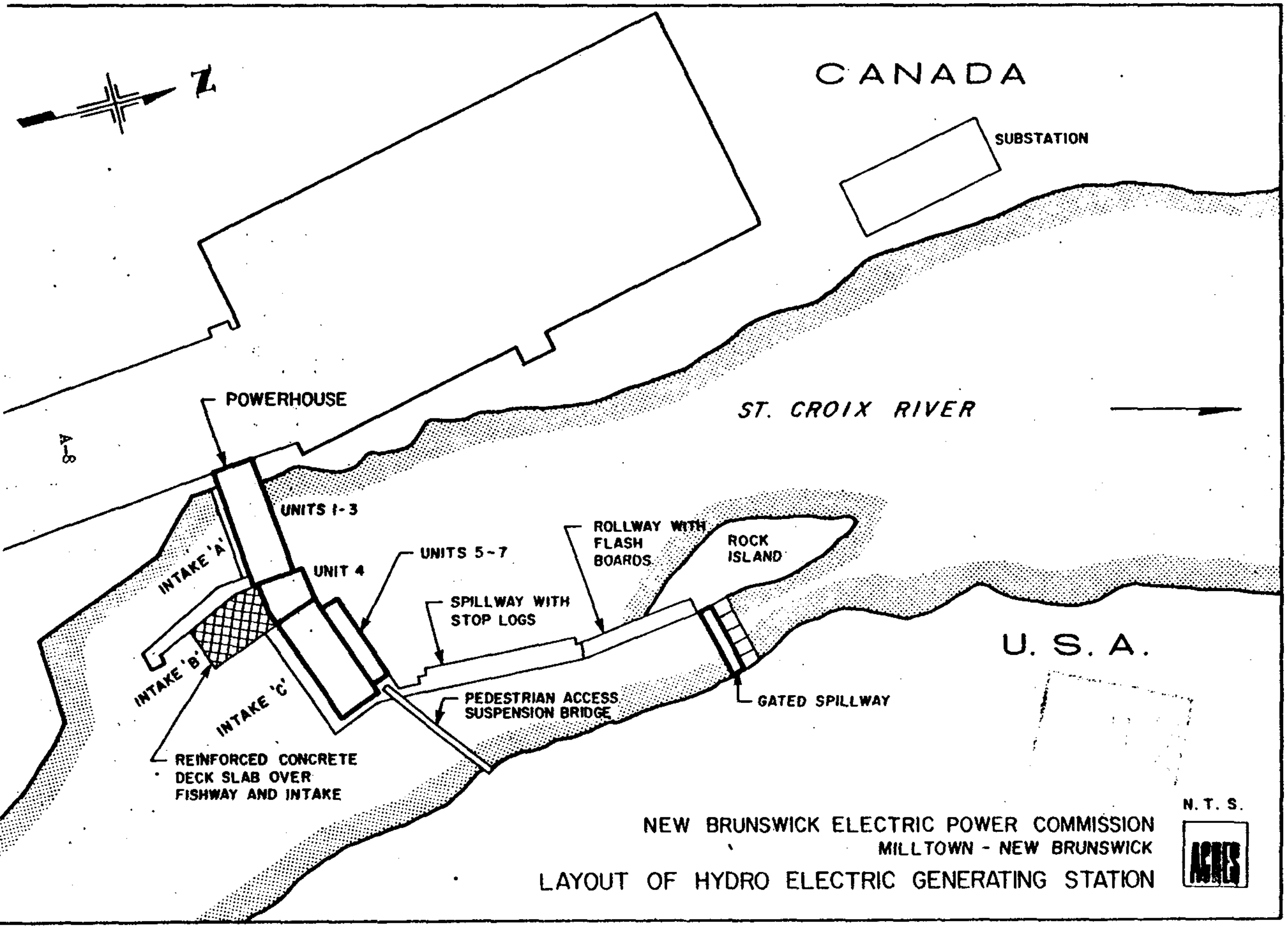
5 - CONTROL STRUCTURES

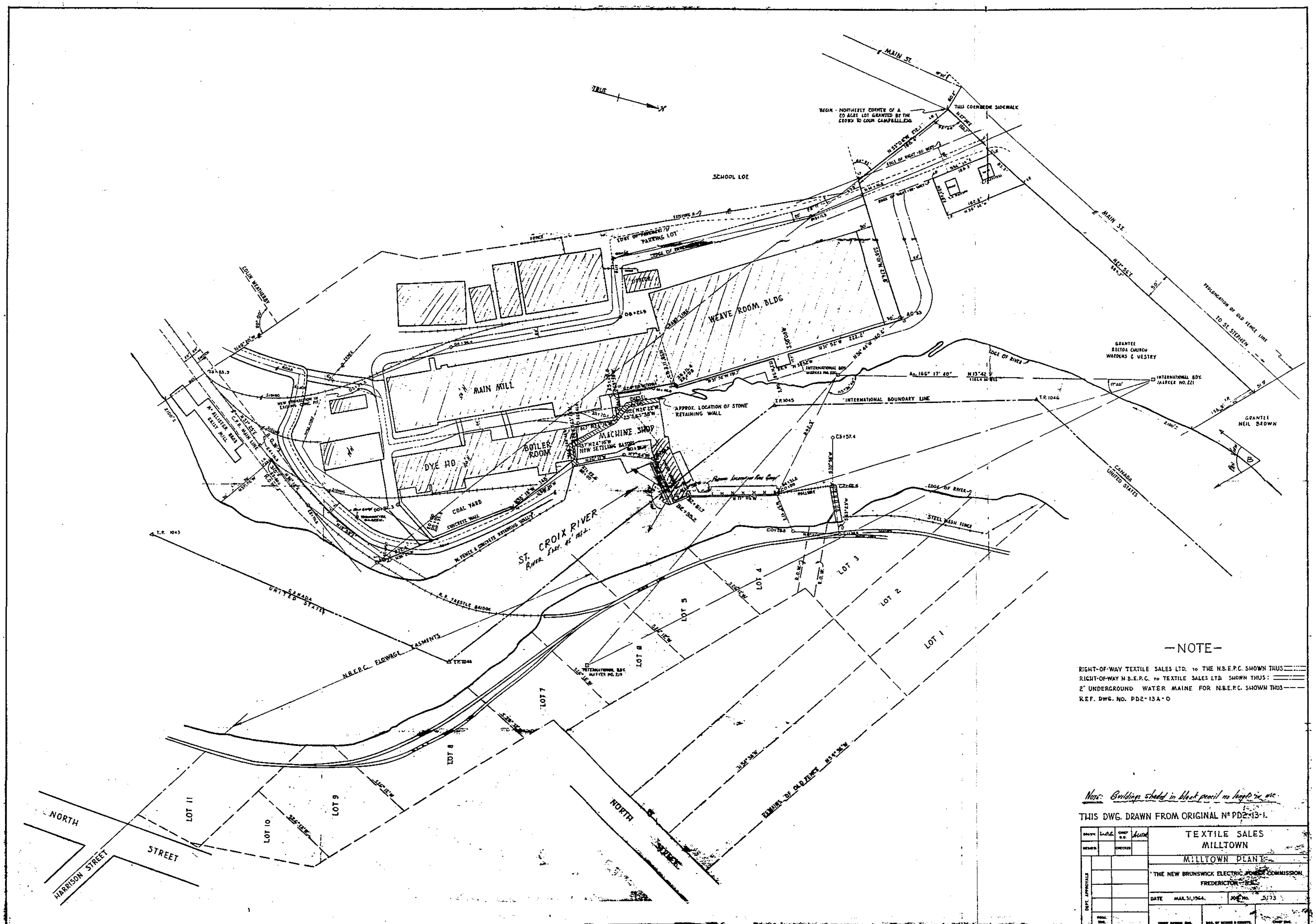
These all show surface spalling, efflorescence and staining and the rollway weir has aggregate exposed over its full length.

However, continual annual maintenance is being carried out including resurfacing of large areas with new concrete. The structures therefore operate adequately and there is no danger of collapse or unstability.

The suspension bridge cables, hangers, anchors and the timber walkway are all in reasonably good condition.

S. Maitland


N
CANADA
SUBSTATION
POWERHOUSE
ST. CROIX RIVER
UNITS 1-3
INTAKE 'A'
UNIT 4
UNITS 5-7
ROLLWAY WITH FLASH BOARDS
ROCK ISLAND
SPILLWAY WITH STOP LOGS
U. S. A.
INTAKE 'B'
INTAKE 'C'
PEDESTRIAN ACCESS SUSPENSION BRIDGE
GATED SPILLWAY
REINFORCED CONCRETE DECK SLAB OVER FISHWAY AND INTAKE
N. T. S.
NEW BRUNSWICK ELECTRIC POWER COMMISSION
MILLTOWN - NEW BRUNSWICK
LAYOUT OF HYDRO ELECTRIC GENERATING STATION
ACRES



—NOTE—

RIGHT-OF-WAY TEXTILE SALES LTD. to THE N.B.E.P.C. SHOWN THUS

RIGHT-OF-WAY N.B.E.P.C. to TEXTILE SALES LTD. SHOWN THUS:

2" UNDERGROUND WATER MAINE FOR N.B.E.P.C. SHOWN THUS

REF. DWG. NO. PD2-13A-0

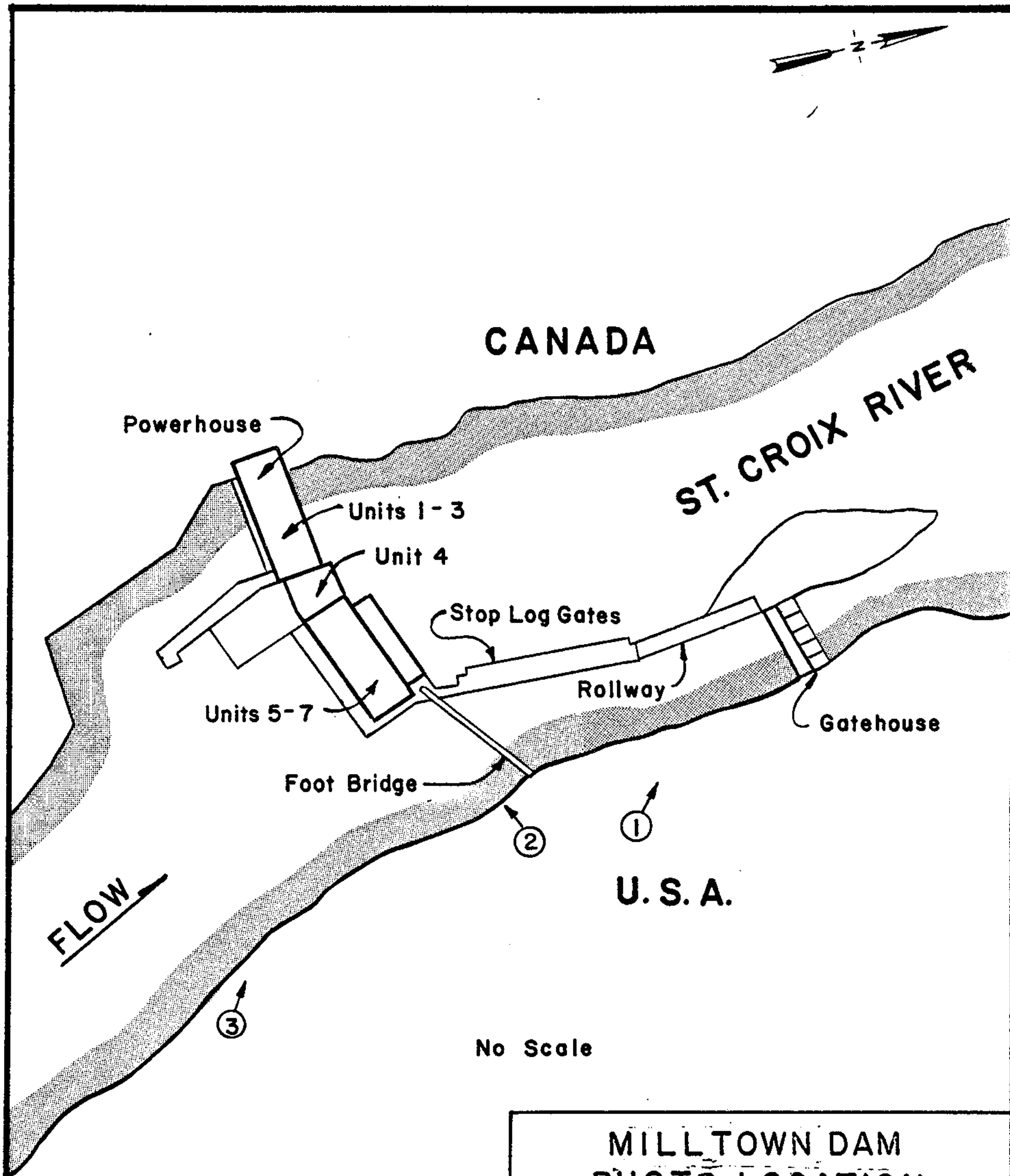
Note: Buildings shaded in black pencil no longer in use.

THIS DWG. DRAWN FROM ORIGINAL Nº PD2-13-1.

DRAWN: L.O.E.	TEXTILE SALES MILLTOWN
	MILLTOWN PLANT
	THE NEW BRUNSWICK ELECTRIC POWER COMMISSION FREDERICTON - N.B.
	DATE MAR. 31, 1964. JOB No. 5173
SCALE: 1" = 60'	DWG. Nº 5173-81

APPENDIX B

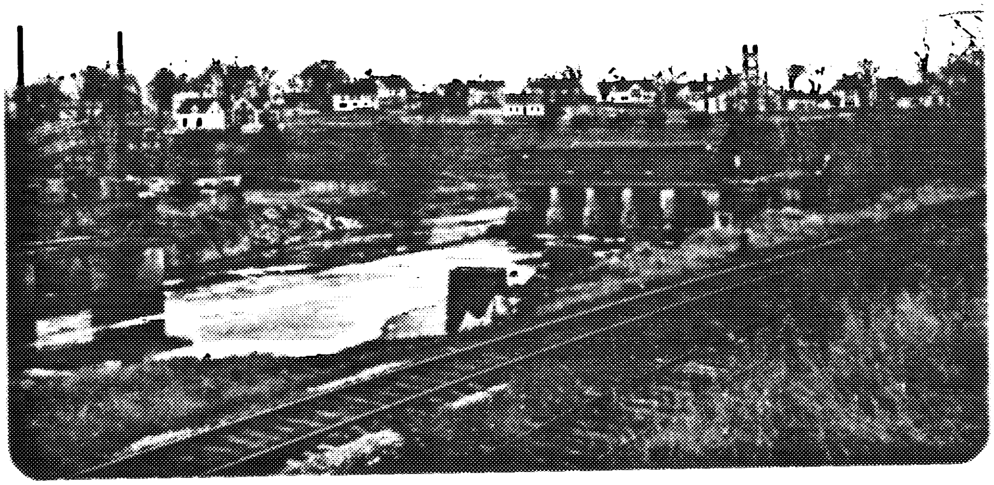
PHOTOGRAPHS



MILLTOWN DAM
PHOTO LOCATION

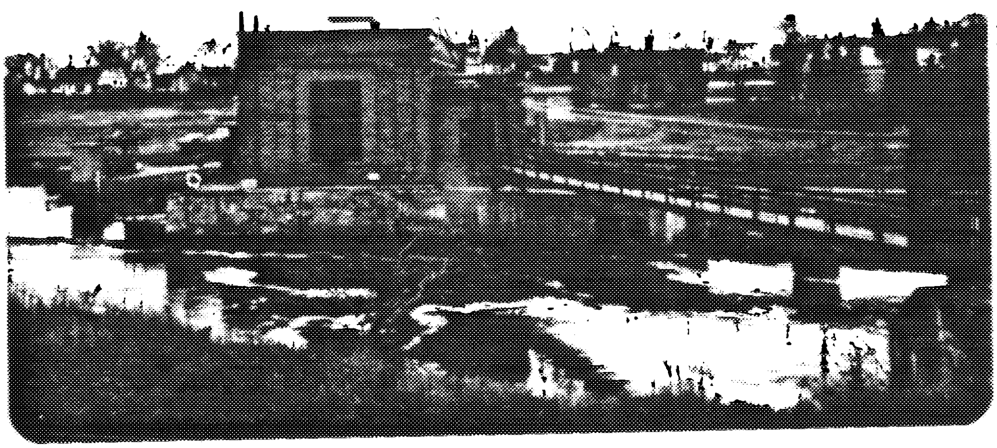
U.S. ARMY CORPS OF ENGINEERS
PHASE I INSPECTION PROGRAM

MAIN	DATE		
	CLIENT	JOB	PLATE
	1345	72	2



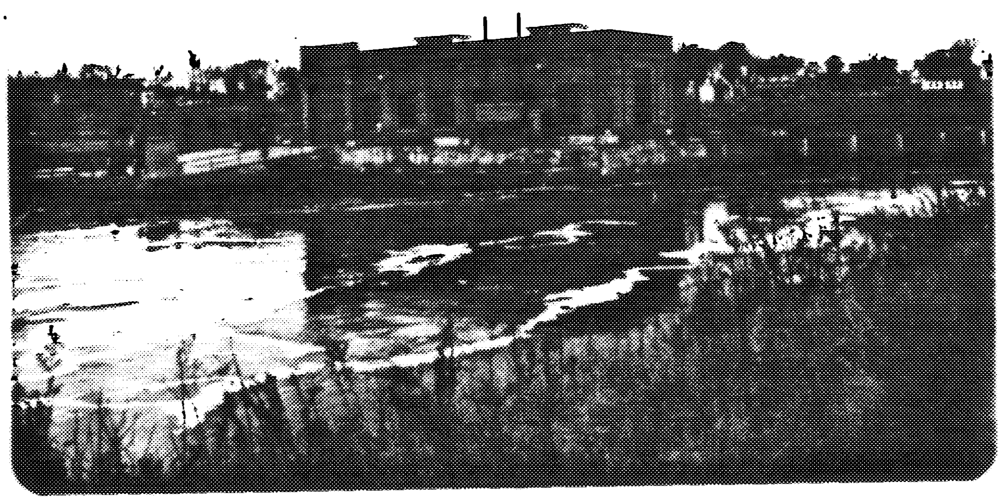
#1

View of the right side of the dam including the gate-house (at right) and the rollway section (center).



#2

View of powerhouse and pedestrian bridge from right bank.



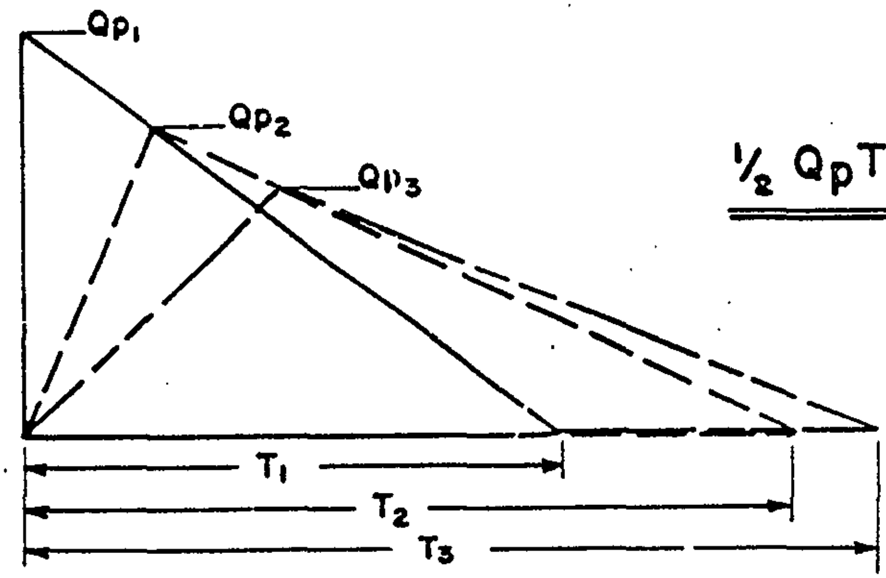
#3

View of powerhouse and stop-log gates at far right.

APPENDIX C

HYDROLOGIC COMPUTATIONS

"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



$\frac{1}{2} Q_p T = 12 S$

STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Q_{p1} = \frac{8}{27} W_b \sqrt{g}\, Y_0^{3/2}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_0 = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOPMANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Q_{p2}(\text{TRIAL}) = Q_{p1}\left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

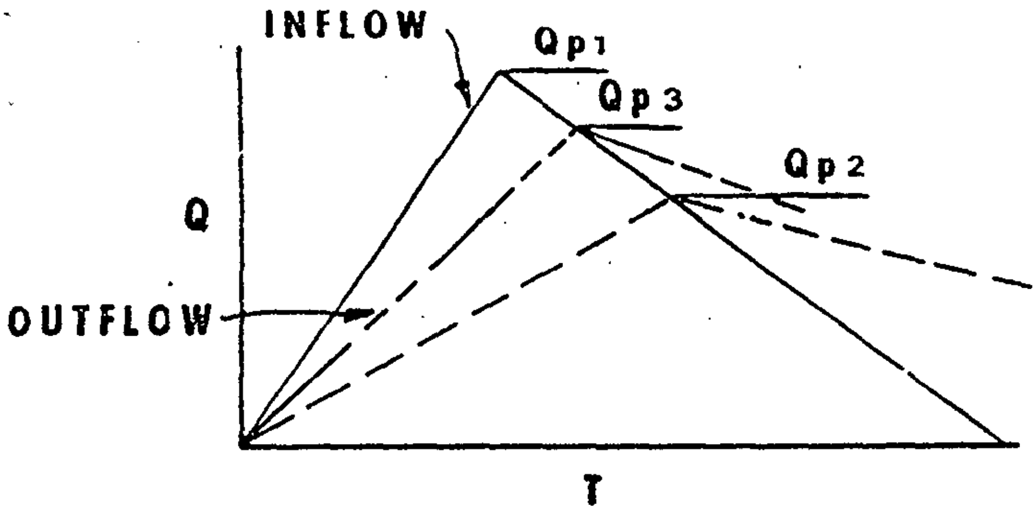
D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Q_{p2} = Q_{p1}\left(1 - \frac{V_{avg}}{S}\right)$$

STEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Qp_1) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Qp_1".

b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore:

$$Qp_2 = Qp_1 \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Qp_3".

SURCHARGE STORAGE ROUTING SUPPLEMENT

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Avg "$STOR_1$" and "$STOR_2$" and Compute "Qp_3".

c. If Surcharge Height for Qp_3 and "$STOR_{AVG}$" agree O.K. If Not:

STEP 4: a. Determine Surcharge Height and "$STOR_3$" To Pass "Qp_3"

b. Avg. "Old $STOR_{AVG}$" and "$STOR_3$" and Compute "Qp_4"

c. Surcharge Height for Qp_4 and "New $STOR_{Avg}$" should Agree closely

MAIN

Client: CORPS OF ENGINEERS Job No. 1345-072 Sheet 1 of 17
Subject: MILLTOWN DAM By T. OTOVA Date 3/9/81
FLOOD ROUTING Ckd. Rev.

Drainage Area is 1460 square miles.

The dam is a gated spillway control structure. The highest recorded flow occured in May 1-2, 1923 which was about 25,000 cfs. Design flood for the dam is 40000 cfs. The reservoir upstream of the Milltown Dam and powerhouse extends to the rapids at the village of Baring, approximately 3.5 miles. The reservoir is shallow, with a moderate volume of storage. Another dam, with considerably greater storage capacity, is located about 10 miles upstream at the village of Woodland. Yet another dam and reservoir are located further upstream.

Because the dam is a control structure no flood routing calculations were performed.

The total length of the dam is 330 ft with total height of 31 fts. Top of the dam capacity is 130 ac.-ft. (From Inventory forms). The dam breach calculations are performed by using these data for 5000 cfs average base flow.

MILLTOWN RESERV.
DAM FAILURE ANALYSES

These calculations are performed according to the RULE OF THUMB procedures of the Corps of Engineers

The breach discharge:
Qp1 = 8/27 * Wb * g^0.5 * Yo^3/2

Where,

Yo is the height of the breach (from river bed to the max. pool level)

Wb is 35% of the length of the dam, or Wb = .35 * Wd

g is the acceleration of the gravity (32.2 ft/sec^2)

Yo = 25 (ft)

Wd = 330 (ft)

Wb = 115 (ft)

From above equation,
Qp1 = 24274 (cfs)

The natural channel cross sections are simplyfied as rectangular cross sections

The stage-discharge relationship becomes as,

h = [(n*Q)/(1.49*b*S^.5)]^(3/5)

Where,

Q = Discharge (cfs)
b = Channel width (ft)
S = Channel slope

The cross section Area:

A = h * b

The Volume of the Reservoir,
V = 130 (ac-ft)
or,
V = 5662800 (cub-ft)

R E A C H (1) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 8.4 (ft)

From Formula (II),
Total Area,
A = 3361 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 2197 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 1098558 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 19565 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 24565 (cfs)

h = 7 (ft)

From Formula (II),

A = 3025 (ft)

Residual Area,

A2 = A - A1

A2 = 1861 (ft)

V2 = A2 * L

V2 = 930699 (cub-ft)

Vave = (V1 + V2) / 2

Vave = 1014629 (cub-ft)

Qp2 = Qp1 * (1 - Vave / V)

Qp2 = 19924 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 7.6 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 7.6 (ft)

3.) Breach Discharge = 19924 (cfs)

4) Reach Length = 500 (ft)

REACH (2) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 7.6 (ft)

From Formula (II),
Total Area,
A = 3051 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 1887 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 943953 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 16603 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 21603 (cfs)

h = 7 (ft)

From Formula (II),

A = 2801 (ft)

Residual Area,

A2 = A - A1

A2 = 1636 (ft)

V2 = A2 * L

V2 = 818474 (cub-ft)

Vave = (V1 + V2) / 2

Vave = 881214 (cub-ft)

Qp2 = Qp1 * (1 - Vave / V)

Qp2 = 16824 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 7 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 7 (ft)

3.) Breach Discharge = 16824 (cfs)

4.) Reach Length = 500 (ft)

R E A C H (3) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 7 (ft)

From Formula (II),
Total Area,
A = 2818 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 1654 (sq-ft)

Residual Volume,

V1 = L * A2

W1 = 827043 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 14367 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 19367 (cfs)

h = 6 (ft)

From Formula (II),

A = 2623 (ft)

Residual Area,

A2 = A - A1

A2 = 1459 (ft)

V2 = A2 * L

V2 = 729591 (cub-ft)

Vave = (V1 + V2) / 2

Vave = 778317 (cub-ft)

Qp2 = Qp1 * (1 - Vave / V)

Qp2 = 14511 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 6.5 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 6.5 (ft)

3.) Breach Discharge = 14511 (cfs)

4) Reach Length = 500 (ft)

R E A C H (4) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 6.5 (ft)

From Formula (II),
Total Area,
A = 2635 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 1470 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 735465 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 12627 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 17627 (cfs)

h = 6 (ft)

From Formula (II),

A = 2479 (ft)

Residual Area,

A2 = A - A1

A2 = 1315 (ft)

V2 = A2 * L

V2 = 657560 (cub-ft)

Vave = (V1 + V2) / 2

Vave = 696512 (cub-ft)

Qp2 = Qp1 * (1 - Vave / V)

Qp2 = 12726 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 6.2 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 6.2 (ft)

3.) Breach Discharge = 12726 (cfs)

4.) Reach Length = 500 (ft)

(MAIN)

Client: Corps of Engineers — Job No. 1345-72 — Sheet 7 of 17
Subject: Dam Failure Analysis — By: T. Otova — Date: 3/9/81
Milltown Dam — Ckd. — Rev.

R E A C H (5) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 6.2 (ft)

From Formula (II),
Total Area,
A = 2487 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 1323 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 661767 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 11239 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 16239 (cfs)

h = 5 (ft)

From Formula (II),

A = 2360 (ft)

Residual Area,

A2 = A - A1

A2 = 1196 (ft)

V2 = A2 * L

V2 = 598059 (cub-ft)

Vavg = (V1 + V2) / 2

Vavg = 629913 (cub-ft)

Qp2 = Qp1 * (1 - Vavg / V)

Qp2 = 11311 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 5.9 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 5.9 (ft)

3.) Breach Discharge = 11311 (cfs)

4.) Reach Length = 500 (ft)

REACH (6) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 5.9 (ft)

From Formula (II),
Total Area,
A = 2366 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 1202 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 601178 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 10110 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 15110 (cfs)

h = 5 (ft)

From Formula (II),

A = 2260 (ft)

Residual Area,

A2 = A - A1

A2 = 1096 (ft)

V2 = A2 * L

V2 = 548115 (cub-ft)

Vavg = (V1 + V2) / 2

Vavg = 574646 (cub-ft)

Qp2 = Qp1 * (1 - Vavg / V)

Qp2 = 10163 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 5.6 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 5.6 (ft)

3.) Breach Discharge = 10163 (cfs)

4) Reach Length = 500 (ft)

(MAIN)

Client Corps of Engineers   Job No. 1345-72   Sheet 9 of 17
Subject Dam Failure Analysis   By T. Otova   Date 3/9/81
Milltown Dam   Chkd.   Rev.

REACH (7) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 5.6 (ft)

From Formula (II),
Total Area,
A = 2265 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 1100 (sq-ft)

Residual Volume,

V1 = L * A2.

V1 = 550492 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 9175 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 14175 (cfs)

h = 5 (ft)

From Formula (II),

A = 2175 (ft)

Residual Area,

A2 = A - A1

A2 = 1011 (ft)

V2 = A2 * L

V2 = 505621 (cub-ft)

Vavg = (V1 + V2) / 2

Vavg = 528056 (cub-ft)

Qp2 = Qp1 * (1 - Vavg / V)

Qp2 = 9215 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 5.4 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 5.4 (ft)

3.) Breach Discharge = 9215 (cfs)

4.) Reach Length = 500 (ft)

(MAIN)

R E A C H (8) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 5.4 (ft)

From Formula (II),
Total Area,
A = 2179 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 1014 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 507473 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 8389 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 13389 (cfs)

h = 5 (ft)

From Formula (II),

A = 2102 (ft)

Residual Area,

A2 = A - A1

A2 = 938 (ft)

V2 = A2 * L

V2 = 469042 (cub-ft)

Vave = (V1 + V2) / 2

Vave = 488258 (cub-ft)

Qp2 = Qp1 * (1 - Vave / V)

Qp2 = 8421 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 5.2 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 5.2 (ft)

3.) Breach Discharge = 8421 (cfs)

4) Reach Length = 500 (ft)

R E A C H (9) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 5.2 (ft)

From Formula (II),
Total Area,
A = 2105 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 941 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 470514 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 7721 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 12721 (cfs)

h = 5 (ft)

From Formula (II),

A = 2038 (ft)

Residual Area,

A2 = A - A1

A2 = 874 (ft)

V2 = A2 * L

V2 = 437238 (cub-ft)

Vavg = (V1 + V2) / 2

Vavg = 453876 (cub-ft)

Qp2 = Qp1 * (1 - Vavg / V)

Qp2 = 7746 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 5.1 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 5.1 (ft)

3.) Breach Discharge = 7746 (cfs)

4.) Reach Length = 500 (ft)

REACH (10) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 5.1 (ft)

From Formula (II),
Total Area,
A = 2040 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 876 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 438427 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 7146 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 12146 (cfs)

h = 4 (ft)

From Formula (II),

A = 1982 (ft)

Residual Area,

A2 = A - A1

A2 = 818 (ft)

V2 = A2 * L

V2 = 409341 (cub-ft)

Vavg = (V1 + V2) / 2

Vavg = 423884 (cub-ft)

Qp2 = Qp1 * (1 - Vavg / V)

Qp2 = 7166 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 4.9 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 4.9 (ft)

3.) Breach Discharge = 7166 (cfs)

4) Reach Length = 500 (ft)

(MAIN)

Client: CORPS of ENGINEERS — Job No. 1345-72 — Sheet 13 of 17
Subject: DAM FAILURE ANALYSIS — By T. OTOVA — Date 3/9/81
MILLTOWN DAM — Ckd. — Rev.

REACH (11) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 4.9 (ft)

From Formula (II),
Total Area,
A = 1984 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 820 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 410315 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 6647 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 11647 (cfs)

h = 4 (ft)

From Formula (II),

A = 1933 (ft)

Residual Area,

A2 = A - A1

A2 = 769 (ft)

V2 = A2 * L

V2 = 384681 (cub-ft)

Vave = (V1 + V2) / 2

Vave = 397498 (cub-ft)

Qp2 = Qp1 * (1 - Vave / V)

Qp2 = 6663 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 4.8 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 4.8 (ft)

3.) Breach Discharge = 6663 (cfs)

4.) Reach Length = 500 (ft)

(MAIN)

Client: Corps of Engr's — Job No. 1345-072 — Sheet 14 of 17

Subject: Dam Failure Analysis — By: T. Otova — Date: 3/9/81

Milltown Dam — Ckd. — Rev.

R E A C H (12) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 4.8 (ft)

From Formula (II),
Total Area,
A = 1935 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 770 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 385489 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 6209 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 11209 (cfs)

h = 4 (ft)

From Formula (II),

A = 1889 (ft)

Residual Area,

A2 = A - A1

A2 = 725 (ft)

V2 = A2 * L

V2 = 362733 (cub-ft)

Vavg = (V1 + V2) / 2

Vavg = 374111 (cub-ft)

Qp2 = Qp1 * (1 - Vavg / V)

Qp2 = 6223 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 4.7 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 4.7 (ft)

3.) Breach Discharge = 6223 (cfs)

4) Reach Length = 500 (ft)

REACH (13) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 4.7 (ft)

From Formula (II),
Total Area,
A = 1890 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 726 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 363410 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 5823 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 10823 (cfs)

h = 4 (ft)

From Formula (II),

A = 1850 (ft)

Residual Area,

A2 = A - A1

A2 = 686 (ft)

V2 = A2 * L

V2 = 343078 (cub-ft)

Vavg = (V1 + V2) / 2

Vavg = 353244 (cub-ft)

Qp2 = Qp1 * (1 - Vavg / V)

Qp2 = 5834 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 4.6 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 4.6 (ft)

3.) Breach Discharge = 5834 (cfs)

4) Reach Length = 500 (ft)

(MAIN)

Client Corps of Engr's Job No. 1345-072 Sheet 16 of 17
Subject Dam Failure Analysis By T. Otova Date 3/9/81
Milltown Dam Ckd. ______ Rev. ______

REACH (14) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 4.6 (ft)

From Formula (II),
Total Area,
A = 1851 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 687 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 343650 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 5480 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 10480 (cfs)

h = 4 (ft)

From Formula (II),

A = 1814 (ft)

Residual Area,

A2 = A - A1

A2 = 650 (ft)

V2 = A2 * L

V2 = 325378 (cub-ft)

Vavg = (V1 + V2) / 2

Vavg = 334514 (cub-ft)

Qp2 = Qp1 * (1 - Vavg / V)

Qp2 = 5490 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 4.5 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 4.5 (ft)

3.) Breach Discharge = 5490 (cfs)

4.) Reach Length = 500 (ft)

MAIN

Client Corps of Engr's Job No. 1345-072 Sheet 17 of 17
Subject Dam Failure Analysis By T. Otova Date 3/9/81
Milltown Dam Ckd. Rev.

R E A C H (15) CALCULATIONS

Test flood discharge:
Qt = 5000 (cfs)

b = 400 (ft)
S = .0008
n = .02
L = 500 (ft)

From Formula (I),

Prefailure height,

h1 = 2.9 (ft)

From Formula (II) ,

A1 = 1164 (sq.ft.)

Q = Qp1 + Qt

From Formula (I),
Total Height,
h = 4.5 (ft)

From Formula (II),
Total Area,
A = 1815 (sq-ft)

Residual Area,
A2 = A - A1
A2 = 651 (sq-ft)

Residual Volume,

V1 = L * A2

V1 = 325867 (cub-ft)

Qp2 = Qp1 * (1 - V1 / V)

Qp2 = 5174 (cfs)

From Formula (I),

Q=Qp2+Qt

Q = 10174 (cfs)

h = 4 (ft)

From Formula (II),

A = 1782 (ft)

Residual Area,

A2 = A - A1

A2 = 618 (ft)

V2 = A2 * L

V2 = 309361 (cub-ft)

Vave = (V1 + V2) / 2

Vave = 317614 (cub-ft)

Qp2 = Qp1 * (1 - Vave / V)

Qp2 = 5182 (cfs)

From Formula (I),

Q = Qp2 + Qt

h2 = 4.4 (ft)

RESULTS :

1.) Prefailure Height = 2.9 (ft)

2.) Postfailure Height = 4.4 (ft)

3.) Breach Discharge = 5182 (cfs)

4.) Reach Length = 500 (ft)

APPENDIX D

INVENTORY FORMS

PART I – INVENTORY OF DAMS IN THE UNITED STATES

(PURSUANT TO PUBLIC LAW 92–367)

See reverse side for instructions.

FORM APPROVED
OMB NO. 49- R0421

REQUIREMENTS CONTROL SYMBOL
DAEN-CWE-17

[1] STATE	IDENTITY NUMBER
ME	00217

IDENTIFICATION

[2] DIVISION	[3] STATE	[4] COUNTY	[5] CONGR DIST	[6] STATE	[7] COUNTY	[8] CONGR DIST	[9] NAME	[10] LATITUDE (North)	[11] LONGITUDE (West)	[12] REPORT DATE DAY MO YR	
NED	ME	029	02				MILLTOWN POWER STATION DAM	4510.5	6717.5	26 MAR 81	0

IDENTIFICATION (Continued)

[13] POPULAR NAME	[14] NAME OF IMPOUNDMENT	
MILLTOWN DAM	NONE	1

LOCATION

[15] REGION	[16] BASIN	[17] RIVER OR STREAM	[18] NEAREST DOWNSTREAM CITY – TOWN – VILLAGE	[19] DIST FROM DAM (mi)	[20] POPULATION	
01	01	SAINT CROIX RIVER	CALAIS	1	4000	2

STATISTICS

[21] TYPE OF DAM	[22] YEAR COMPLETED	[23] PURPOSES	[24] STRUCTURAL HEIGHT (ft)	[25] HYDRAULIC HEIGHT (ft)	[26] IMPOUNDING CAPACITIES MAXIMUM (acre – ft.)	[27] IMPOUNDING CAPACITIES NORMAL (acre – ft.)	[27A] CORPS ENGR. DIST.	[27B] OWN.	[27C] FED. R.	[27D] PRV/FED	[27E] SCS A.	[27F] VERIFICATION DATE DA MO YR	BLANK	
PG	1900	H	31	25	130	110	NED	N	N	N	N			3

REMARKS

[28] REMARKS	
	4

ENG FORM 1 DEC 77 4474

PART II – INVENTORY OF DAMS IN THE UNITED STATES
(PURSUANT TO PUBLIC LAW 92-367)

See reverse side for instructions.

FORM APPROVED
OMB NO. 49–R0421
REQUIREMENTS CONTROL SYMBOL
DAEN–CWE–17

[1] STATE (1–2)	IDENTITY NUMBER (3–7)
ME	00217

STATISTICS

[29] HAZ (8)	[30] CREST LENGTH (ft) (9–13)	[31] SPILLWAY TYPE (14)	[32] SPILLWAY WIDTH (ft) (15–18)	[33] SPILLWAY MAXIMUM DISCHARGE (cfs) (19–25)	[34] VOLUME OF DAM (CY) (26–34)	[35] POWER CAPACITY INSTALLED (MW) (35–40)	[36] POWER CAPACITY PROPOSED (MW) (41–46)	[37] NAVIGATION LOCKS NO. (47)	[38] LENGTH (ft)	[39] WIDTH (ft)	[40] LENGTH (ft)	[41] WIDTH (ft)	[42] LENGTH (ft)	[43] WIDTH (ft)	[44] LENGTH (ft)	[45] WIDTH (ft)	BLANK	80
3	540	U	125	25000		31		0										5

MISC DATA

[46] OWNER (8–31)	[47] ENGINEERING BY (32–55)	[48] CONSTRUCTION BY (56–79)	80
NEW BRUNSWICK ELEC P C		CANADIAN COTTON	6

MISC. DATA (Continued)

REGULATORY AGENCY: [49] DESIGN (8–25)	[50] CONSTRUCTION (26–43)	[51] OPERATION (44–61)	[52] MAINTENANCE (62–79)	80
NONE	NONE	NONE	NONE	7

MISC. DATA (Continued)

[53] INSPECTION BY (8–40)	[54] INSPECTION DATE DAY / MO / YR (41–47)	[55] AUTHORITY FOR INSPECTION (48–79)	80
SHAWINIGAN ENGR LTD	31 DEC 72	N B. E. A. C.	8

REMARKS

[56] REMARKS (8–79)	80
14- 125 FT CONTROLLED 100 FT UNCONTROLLED	9